Abstract. The purpose of this qualitative research is to examine the views of 21 secondary mathematics student teachers attending Mathematical Modelling Course regarding mathematical modelling in a state university in Turkey; reasons why they chose this course and their expectations from the course in question. For this reason, three open-ended questions were asked to the participants and they gave their answers in writing. These questions were related to their description of mathematical modelling, the reason why they chose this course and their expectations related to this course. The data obtained from responses to these questions were examined and categorized using content analysis. Data analysis showed that the participants generally defined mathematical modelling as making mathematical concepts more concrete, developing material, associating mathematics with real world and solving daily life problems. Among participants’ reasons why they chose this course, it was pointed out that this course would fulfill the requirements of Secondary School Mathematics Curriculum. Participants’ expectations related to this course are retention of mathematical knowledge, making mathematical concepts more concrete and more relevant to daily life; making their future students more active; contributing to their future teaching life.

Keywords: Mathematical modelling, mathematics student teacher, teachers’ views.
students seeing mathematics as a source of production in their lives outside school and in creating a suitable environment for the improvement of their mathematical skills (Freudenthal (1973), Stevens (2000), Streefland (1993) in English (2006)). So, while teachers’ use of mathematical modelling when they teach will show the students how important mathematics is to continue their lives, this will also help them improve their mathematical knowledge and abilities. In this context, it is considered to be important for the mathematics student teachers to take courses related to mathematical modelling during their undergraduate education in order to be able to use mathematical modelling in their lessons after they graduate. Such a course will contribute to the improvement of their ideas about modelling in a positive way and help them have enough knowledge on modelling. There is no course related to mathematical modelling in the curriculum of the secondary school mathematics education in Turkey. In the teacher education program, mathematical modelling is offered as an elective course. So, many student teachers can graduate with their own present knowledge and experiences without learning about modelling. This study is based on revealing the conditions of the student teachers before taking the mathematical modelling course. It is also important that the student teachers express their views about the meaning of mathematical modelling, the reasons why they have chosen a course related to mathematical modelling with which they can increase their knowledge and finally their expectations from this course. To this respect, the aim of the study is to find out the views of the secondary school mathematics student teachers about mathematical modelling, the reasons why they have chosen a course related to mathematical modelling and their expectations from this course.

Method
This is a qualitative study which was carried out using surveys to find out the views of the secondary school mathematics student teachers about mathematical modelling, the reasons why they have chosen a course related to mathematical modelling and their expectations from this course.

Participants
The study was carried out as part of the Mathematical Modelling course in the fall term of 2010-2011. This course is an elective course provided in the department of secondary school mathematics education of a state university in Turkey. The participants of the study were twenty one student teachers, twelve female and nine male, who took the Mathematical Modelling course. The participants were labelled using the initials: ST₁, ST₂, ST₃, …, ST₂₁.
**Instruments**

The mathematics student teachers answered three survey questions in writing. These questions are stated in Figure 1.

**Figure 1.** Three survey questions asked to student teachers

Dear Student Teachers,

This study is carried out in order to find out the student teachers’ definition of mathematical modeling, the reasons why they choose a course related to mathematical modeling and their expectations from this course. In the instruments that we expect you to answer honestly, there are open-ended questions that we ask you to answer.

THANK YOU for participating in our study.

The Questions about Mathematical Modeling and Mathematical Modeling Course

1. What do you think mathematical modeling is?
2. Why did you choose a course related to mathematical modeling?
3. What are your expectations from this course?

**The Analysis of the Data**

The answers that the student teachers gave to these three open-ended questions were analyzed through content analysis. Content analysis is a research technique for making replicable and valid inferences from texts to the context of their use (Krippendorff, 2004). Firstly, the answers of the student teachers were written in the Office Word form and then those were examined by three researchers separately. It was observed that the data which was analyzed separately for each question by three researchers at the same time were gathered under certain codes and themes. Within the framework of the basic codes that emerged in this process, common or very similar themes were detected in the reports of each researcher as a result of a constant comparison of the answers of the participants with one another. Afterwards, an evaluation was carried out among the researchers to clarify the codes and the themes so that the reliability of the study (coding consistency) could be demonstrated. After the mentioned evaluation process, the views of the student teachers who were chosen by two researchers were examined and the inter-coder reliability formula

\[
\text{Reliability} = \frac{\text{number of agreements between coders}}{\text{total number of agreements and disagreements}}
\]

which was devised by
Miles and Huberman (1994) was used in this examination process. The inter-coder reliability method involved different researchers coding similar data with the aim of obtaining the same codes for the same data using the same classification system (Miles and Huberman, 1994).

In the examination of the views of the chosen student teachers, 20 consensuses and 4 dissidences were detected and in this regard, the reliability was calculated as 83.3%. The codes which were formed in this study and the themes connected to these codes were given as follows:

About process of defining the mathematical modeling and these definitions (Table 1);

Code I- Comprehending the subject

Theme I-a. concretization,

Theme I-b. associating with real life,

Theme I-c. developing materials,

Theme I-d. teaching method.

Code II- The process of problem solving

Theme II-a. transforming a daily life problem into a mathematical problem and solving it,

Theme II-b. moving a mathematical problem into daily life and solving it.

About the reasons why they chose a course related to mathematical modeling (Table 2);

Code I- The reasons why they chose this course

Theme I-a. fulfilling the requirements of the new curriculum,

Theme I-b. the instructor of the course,

Theme I-c. the recommendations of the student teachers who took the course before,

Theme I-d. convenience to the schedule.

About their expectations from this course (Table 3);

Code I- The mathematical knowledge
Theme I-a. making it retention,
Theme I-b. making it more concrete,
Theme I-c. making students like it,
Theme I-d. making it applicable.

Code II- The lessons
Theme II-a. associating with daily life,
Theme II-b. making it more comprehensible and meaningful,
Theme II-c. bringing about learning,
Theme II-d. using different methods and techniques.

Code III- The students
Theme III-a. making them more active,
Theme III-b. encouraging them to think and reason.

Code IV- Personal development
Theme IV-a. contributing to the career,
Theme IV-b. making them gain a different point of view,
Theme IV-c. increasing the mathematical thinking.

The results obtained from the analysis of the data will be presented in the next chapter within the framework of each code and theme. While presenting the results within the context of each code and theme, the number of the student teachers who pointed out to the code and the theme in question is given in the column “the student teachers who pointed out” and the number of the participants who pointed out and the percentages are given in the column “the number (percentage) of the expressions”. The round percentages were calculated as proportion of the number of the student teachers who pointed out the themes or codes to the number of the whole student teachers.

**Results**
The results obtained from the answers given by student teachers to the question “What do you think the mathematical modelling is?” were given in Table 1.

Table 1. Defining mathematical modelling and the results regarding the definitions

<table>
<thead>
<tr>
<th>The student teacher who pointed out</th>
<th>The number (percentage) of the expressions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stating he/she does not know</td>
<td>ST1 - ST21 2 (10 %)</td>
</tr>
<tr>
<td>Stating he/she knows a little</td>
<td>ST2 - ST6 - ST8 - ST9 - ST10 - ST11 - ST12 - ST13 - ST14 - ST15 - ST16 - ST18 - ST19 - ST20 17 (81%)</td>
</tr>
<tr>
<td>Trying to define true or false</td>
<td>ST2 - ST5 - ST6 - ST7 - ST9 - ST10 - ST11 - ST12 - ST14 - ST15 - ST17 - ST19 - ST20 14 (67%)</td>
</tr>
</tbody>
</table>

Regarding comprehending the subject
- Concretization: ST7 - ST9 - ST10 - ST12 - ST20 6 (29%)
- Associating with daily life: ST2 - ST5 - ST6 - ST7 - ST9 - ST11 - ST19 5 (24%)
- Developing material: ST2 - ST5 - ST9 - ST15 - ST19 5 (24%)
- Teaching method: ST2 - ST6 - ST14 3 (14%)

Regarding process of problem solving
- Transforming a daily life problem into a mathematical problem and solving it: ST4 - ST6 - ST8 - ST13 4 (19%)
- Moving a mathematical problem into daily life and solving it: ST8 - ST9 - ST17 3 (14%)

When Table 1 was examined, it was observed that two student teachers did not know the meaning of the mathematical modelling at all so they couldn’t make a definition of it. Most of the participants (81%) stated that they did not know the definition of the mathematical modelling exactly. Similarly, Berry and Houston (1995), De Corte, Verschaffel, and Greer (2000), and Moscardini (1989) emphasized that the participating student teachers did not state the definition of mathematical modelling exactly (Özer Keskin, 2008). Besides, some participants (67%) who stated that they did not know the mathematical modelling exactly expressed that they made interpretations about it based on the lexical meaning of the mathematical modelling or what they had heard from the student teachers who had already taken this course:

*I have no idea about modelling but I can try to make a definition based on its lexical meaning.* (ST7)

*I don’t know exactly what modelling is. I only heard the ideas of the students who previously took this course.* (ST15)

The above mentioned interpretations of the participants, whether correct or not, are given in Table 1 through the codes and the themes that were under the category of defining mathematical modelling. When the written answers of the student teachers were examined, it was observed that the answers were categorized into two codes: comprehending the subject and the process of problem solving. The first code about comprehending the subject consisted...
of four themes. It was observed that, among these themes student teachers pointed out to the concretization (%29) most. The expressions of the participants stating that the mathematical modelling was a kind of concretization, are as follows:

Actually I have never come across the definition of mathematical modelling or its description. But I think that it is a method which helps us concretize the subjects that we talk about. (ST₃)
I have no idea about what mathematical modelling is. When I heard it, the first thing that came into my mind was that it could be concretization. I think, the abstract concepts are concretized as much as possible in mathematical modelling in order to help the students comprehend the subject. (ST₁₂)

The definitions stating that mathematical modelling is about associating with daily life were given by 24% of the student teachers. Moreover the student teachers defined the mathematical modelling as the problems encountered in daily life similar to the studies of Ärlebäck (2010) and Berry and Houston (1995). In these definitions, associating mathematics with daily life was pointed out and the expressions of two student teachers are as follows:

I don’t exactly know the definition of modelling. But I think that mathematical modelling is to find examples from daily life for the concepts and subjects of mathematics. (ST₁₁)
Mathematical modelling is a concept which shows the relation of mathematics to daily life. (ST₁₂)

While 14% of the participants thought that the mathematical modelling was a method which was used in teaching the subject, 24% of them stated that developing materials for the comprehension of the subject was a mathematical modelling. One student teacher expressed his/her definition of mathematical modelling as developing materials for the comprehension of the subject.

I have never read the definition of mathematical modelling anywhere. If I am to state my opinions about this definition, mathematical modelling is developing materials for the students to comprehend the concepts and subjects of mathematics more easily. (ST₂)

The other code which emerged from the analysis of the answers given by the participants to the question “What is mathematical modelling?” was stated to be the process of problem solving. These statements of the student teachers regarding mathematical modelling are in parallel with the statement of Ärlebäck (2010) and Berry and Houston (1995) that the mathematical modelling is the process of dealing with real life problems. Transforming a daily life problem into a mathematical problem which was stated by 19% of the participants was the first theme of this code. 14% of the participants stated that adapting a mathematical problem to daily life was also a mathematical modelling. The ideas ST₄ and ST₈ stated are as follows:
I cannot give the definition of mathematical modelling exactly. I didn’t know much about this subject until very recently. But I saw it in the secondary mathematics curriculum. In my opinion, modelling is to transform daily life problems into a mathematical problem and solve it. (ST₁)

Mathematical modelling is to express a daily life problem or situation mathematically or try to solve a mathematical problem by adapting it to daily life. (ST₈)

The results obtained from the answers that the student teachers gave to the question “Why did you choose a course related to mathematical modelling?” are given in Table 2.

Table 2. The results regarding the reasons why they chose a course related to mathematical modelling

<table>
<thead>
<tr>
<th>Regarding the reasons why they chose this course</th>
<th>The student teacher who pointed out</th>
<th>The number (percentage) of the expressions</th>
</tr>
</thead>
<tbody>
<tr>
<td>fulfilling the requirements of the new curriculum</td>
<td>ST₂-ST₅-ST₇-ST₈-ST₉-ST₁₀-ST₁₃</td>
<td>9 (43%)</td>
</tr>
<tr>
<td>the instructor of the course</td>
<td>ST₁₂-ST₁₇-ST₂₀</td>
<td></td>
</tr>
<tr>
<td>the recommendations of the student teachers who took the course before</td>
<td>ST₁₂-ST₁₃-ST₁₅</td>
<td>6 (29%)</td>
</tr>
<tr>
<td>convenience to the schedule</td>
<td>ST₁-ST₇</td>
<td>3 (14%)</td>
</tr>
</tbody>
</table>

When Table 2 was examined, it was observed that most of the participants (43%) stated that they chose this course in order to fulfil the requirements of the new secondary school mathematics education curriculum. The expressions of ST₄ and ST₈ in this regard are as follows:

I knew that one of the goals of the curriculum was related to modelling and I would be responsible for this subject so I chose this course. (ST₄)

I chose this course to be able to prepare activities as the new curriculum required. (ST₈)

It was observed that 29% of the participants stated that the instructor of the course played a role in their choosing this course. The opinions of the student teachers in this regard are as follows:

I was already thinking that the three electives one of which we had to choose were all useful for our profession. Actually I chose this course because Mr. ..... was giving it.. (ST₁₄)

I chose this course because I was sure that the instructor could teach us something. (ST₁₆)

The expressions of the student teachers who took advice from the student teachers (29%) who had already taken the course and chose this course are as follows:

I chose this course because an older student whom I trust recommended me to take it. (ST₆)

While choosing this course, actually I consulted to the students who already took this course. I mean I cannot say that I decided myself. One of my reasons to choose this course is that they were thinking that this course was entertaining. (ST₁₃)
10% of the student teachers stated that they chose this course because its class hour was convenient for their schedule. The opinions of ST7 who chose this course due to its convenience for his/her schedule rather than the content of the course are as follows:

Actually while choosing the electives, I paid attention to the hours and the instructor of the course rather than its content. (ST7)

The results obtained from the answers that the student teachers gave to the question “What are your expectations from this course?” are given in Table 3.

Table 3. The results regarding their expectations from this course

<table>
<thead>
<tr>
<th>The student teacher who pointed out</th>
<th>The number (percentage) of the expressions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Regarding mathematical knowledge</strong></td>
<td></td>
</tr>
<tr>
<td>making it retention</td>
<td>ST3-ST5-ST8-ST19-ST14-ST16-ST30</td>
</tr>
<tr>
<td>making it more concrete</td>
<td>ST3-ST7-ST10-ST18-ST19-ST20</td>
</tr>
<tr>
<td>making students like it</td>
<td>ST7-ST8-ST16-ST19-ST20</td>
</tr>
<tr>
<td>making it applicable</td>
<td>ST7-ST8-ST18</td>
</tr>
<tr>
<td><strong>Regarding their instructions</strong></td>
<td></td>
</tr>
<tr>
<td>associating with daily life</td>
<td>ST4-ST5-ST11-ST18-ST19-ST20</td>
</tr>
<tr>
<td>making it more comprehensible and meaningful</td>
<td>ST2-ST3-ST7-ST10-ST12-ST13</td>
</tr>
<tr>
<td>bringing about learning</td>
<td>ST4-ST13-ST14</td>
</tr>
<tr>
<td>using different methods and techniques</td>
<td>ST5-ST15</td>
</tr>
<tr>
<td><strong>Regarding their students</strong></td>
<td></td>
</tr>
<tr>
<td>making them more active</td>
<td>ST3-ST5-ST11-ST19-ST20</td>
</tr>
<tr>
<td>encouraging them to think and reason</td>
<td>ST2-ST4-ST10</td>
</tr>
<tr>
<td><strong>Regarding their personal development</strong></td>
<td></td>
</tr>
<tr>
<td>contributing to the career</td>
<td>ST3-ST5-ST7-ST8-ST10-ST16-ST18</td>
</tr>
<tr>
<td>making them gain a different point of view</td>
<td>ST7-ST19-ST20</td>
</tr>
<tr>
<td>increasing the mathematical thinking</td>
<td>ST3-ST4</td>
</tr>
</tbody>
</table>

The written answers given by student teachers to the question aiming to to reveal their expectations from mathematical modelling course were categorized under four codes as: their expectations about mathematics, about their lessons, about their students and about their personal development. The first of these codes, their expectations about mathematics, has four themes. Most of the student teachers (38%) stated that their expectations from this course were making mathematical knowledge retention. The expectation of ST5 in this regards is as follows:

With the help of modelling, mathematics lessons can be retention. (ST5)

34% of the student teachers stated that they chose this course with the expectation of making mathematical knowledge more concrete and 29% of them stated that they chose it with the expectation of making the students like mathematics. Ärlebäck (2010) stated in his
research that the mathematical modelling is synonymous with the applications of mathematics. According to this study, among the participants’ (14%) expectations from this course are making the mathematical knowledge more applicable in a similar way. The expressions of the student teachers regarding these expectations are as follows:

*I think modelling is an important way to make students like mathematics and make it retention.* (ST\textsubscript{3})

*My expectation from this course is to be able to teach the lesson to the students in a more retention and useful way so that they can internalize it.* (ST\textsubscript{8})

*I think that maybe I can make mathematics more applicable.* (ST\textsubscript{9})

Within the scope of the answers given by student teachers to the question about their expectations from this course, a second code was formed for their lessons and there were four themes under this code. The participants evenly stated that they expected to associate their lessons with daily life (29%) and make them more meaningful (29%). The opinions of ST\textsubscript{8} and ST\textsubscript{18} in this regard are as follows:

*I am expecting to associate mathematics and the daily life incidents better after taking this course.* (ST\textsubscript{8})

*I am expecting that this course can make a connection between mathematics and daily life.* (ST\textsubscript{18})

The other two expectations of the participants from this course were ensuring learning (14%) and using different methods and techniques (10%). The opinions of ST\textsubscript{5} and ST\textsubscript{14} in this regard are as follows:

*I think that this course will help me use different methods and techniques especially in my lessons.* (ST\textsubscript{5})

*I think that this course will help me know about different models.* (ST\textsubscript{14})

My expectation from the modelling course is to ensure my students’ learning in my teaching life. (ST\textsubscript{14})

Two themes which were detected to make students more active and encourage them to think and reason were discussed under the code of their expectations about their future students. 15% of the student teachers stated that they were expecting to encourage their students to think and reason. 24% of the participants stated that they were expecting to make their students more active in the teaching process and one participant expressed his expectation as follows:

*I think mathematical modelling should be used in order to make students more active.* (ST\textsubscript{2})

Within the scope of the answers given by student teachers to the question on their expectations from the course, the final code was formed for their personal development and there were three themes under this code. The theme which the student teachers emphasized most was related to their expectations about the contribution to be made by the course to their career (54%).

*I chose this modelling course as I expect that it will have effect on my teaching career.* (ST\textsubscript{2})
My expectation from this course is to be able to use different models that I learn from this course when I become a teacher in the future. (ST₃)

I am also thinking that I will use what I learn from this course in future. (ST₁₉)

The other three themes were detected to make students gain a different point of view (14%) and increase mathematical thinking (10%). The opinions of ST₃ and ST₁₉ in this regard are as follows:

- I want to be a good teacher and expect this course to help me acquire mathematical thinking. (ST₃)
- I thought as a math teacher that it would help me gain a different point of view to solve the mathematical problems in daily life. (ST₁₉)

Conclusion, Discussion and Implications

In this study, ideas of mathematics student teachers’ regarding the definition of mathematical modelling and their views and expectations related to the Mathematical Modelling course were examined. Although Secondary Mathematics Curriculum in Turkey attaches great importance to mathematical modelling and there are many researches on mathematical modelling in Turkey, no student teachers were able to describe the mathematical modelling properly. Most of the participants who stated that they did not exactly know what the mathematical modelling was, tried to describe it either according to its literal meaning or using what they had heard from the student teachers who took the class before. One of the codes acquired from these descriptions of the participants consisted of themes such as concretization, associating with daily life, developing materials and teaching method, which were expressed for the comprehension of the subject. Under the code of the process of problem solving, the participants described mathematical modelling as solving a daily life problem by transforming it into a mathematical problem and solving a mathematical problem by adapting it to daily life. Özer Keskin (2008), who asked the definition of mathematical modelling to the student teachers using a pre-interview and a pre-questionnaire in her study, stated that the student teachers emphasized the fact that they lacked the knowledge about mathematical modelling. Özer Keskin (2008), conducting a final interview and a final questionnaire to the participants following his study, also stated that none of the student teachers could bring the definition of mathematical modelling as requiring transformation of a real world situation into mathematics. Tekin and Bukova Güzel (2011) also stated that in Turkey the knowledge of secondary mathematics teachers about mathematical modelling was insufficient although the Secondary Mathematics Curriculum emphasizes the mathematical modelling.

The student teachers stated that the reasons why they chose the mathematical modelling course were to meet the requirements of the new curriculum, the instructor of the
recommendations of other student teachers who took that class before and the convenience in terms of the schedule. They expressed their expectations from this mathematical modelling course under the code of expectations about mathematics to be making mathematical knowledge retention applicable and concrete and making the students like mathematics. The expectations of the participants about their lessons were categorized under these themes: associating the lessons with daily life, making them more comprehensible and meaningful, ensuring learning and using different methods and techniques. The student teachers also thought about their future students and stated that they expected to make them more active and encourage them to think and reason. Besides, they stated that they expected this course to contribute to their personal development and specified these expectations as contributing to their career, gaining a different point of view and increasing mathematical thinking. In parallel with the results of this study, it is considered to be important that student teachers take compulsory and elective courses in their undergraduate education which include mathematical modelling in order to improve their knowledge on mathematical modelling. In addition to this, it is recommended that the content of the courses in the mathematics education curriculum should be revised in a way to include mathematical modelling. It is suggested that the foreknowledge of the student teachers about mathematical modelling before taking Mathematical Modelling course and in which directions their ideas have changed at the end of the semester should also be examined for future studies. So the arrangements which should be made in the content of the course for the next semesters can be determined. Although there is an important emphasis on mathematical modelling in both the Secondary Mathematics Curriculum and the international and national research studies, it was seen that the student teachers had problems in terms of existing mathematical modelling knowledge before they had a course and were informed about mathematical modelling. Especially, to resolve these problems before they start to teach, it is considered that instruction should be provided for student teachers on mathematical modelling and this will help them use mathematical modelling in their future professional lives.

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References


